EFFECT OF BIOCOMPOSTED SUGARCANE TRASH AND BAGASSE ON SELECTED CROP PLANTS AND SOIL NUTRIENT STATUS

SYNOPSIS

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INTRODUCTION

Organic agriculture is one of the best method that supports the environment and gives a productive yield. Organic manures are excellent source of plant available nutrients and their addition to soil could maintain high microbial population (Sundararasu, 2016). Among the various sources of organic matter, vermicompost have been recognized as having considerable potential as soil amendments. Several methods have been developed to convert agricultural wastes into organic manure in order to replace inorganic fertilizers. But recently, interest has been shown in the development of eco-friendly novel processes that are based upon the utilization of biological systems (Hemalatha, 2013). The use of organic elements has long been considered as an effective means of improving the structure and fertility of soil. Application of vermicompost produced by biodegradable waste could be one of the most economical and attractive methods to solve the problems of waste disposal and thereby increase the organic matter content of soil (Narkhede *et al.,* 2011).

Vermicompost represents a very suitable medium for plant growth showing improved growth of plants, hence it can be used as a growth substrate in different stages of micropropagation. Vermicomposting is considered a sustainable approach to waste management and agricultural production (Rehman, 2023). Compost is a mixture of decayed plants debris or organic matter, food etc. which is a rich source of nutrients. It can provide a healthy soil environment for plant growth and development. This can reduce the use of chemical fertilizers in agriculture, which directly provides a friendly environment (Rahman *et al*., 2012). Composting is the process of biodegradation of organic matter by microorganisms. which contains high amount of macro and micronutrients essential for plant growth. The organic fraction from municipal solid waste, farm, forest, poultry, dairy and market wastes contains plenty of NPK and other micronutrients which is a good source of soil nutrients (Getnet and Raja, 2013). Million tons of different agricultural wastes produced annually across the country, but a major fraction is burned or left unattended, which leads to environmental pollution (Torkashvand, 2010).

Organic farming is the degradation of organic matter used in order to bring sustainable environment in the ecosystem. Intensive use of chemical fertilizers has its side effect on polluting underground water, destroying microorganism and soil fertility in the ecosystem (Darzi *et al.,* 2012). The usage of inorganic fertilizer, pesticide and insecticide in the lands decline the soil quality and harmful effect to the environment (Perunkotturselvi and Koilraj, 2015).

Agro industrial waste of sugarcane trash and sugarcane bagasse are rich in cellulose and hemicelluloses contents. Insitu composting of cane trash can be a good alternate to mitigate these problem (Viji and Neelanarayanan 2016). On an average a hectare of sugarcane generates about 10 tons of trash. Trash contains 28.6% organic carbon, 0.35 to 0.42% nitrogen, 0.04 to 0.15% phosphorous and 0.50 to 0.42% potassium. The sugarcane trash incorporation in the soil influences physical, chemical and biological properties of the soil. (Shree Harsha Kumar *et al*., 2018). Sugarcane trash incorporation reduces the bulk density of the soil and there is an increase in infiltration rate and decrease in penetration resistance. Sugarcane trash can be easily composted by using the fungi like *Trichurus, Aspergillus, Penicillium and Trichoderma*.

Bagasse is composed largely of cellulose, pentose and lignin. It is made up of 45-55% of cellulose, 20-25% of hemicelluloses and 18-24% lignin (Wan Surya *et al*., 2015). Some reports have described the conversion of bagasse into value-added compost that has the potential to improve productivity of crops and reduce the problem of environmental pollution. Bagasse is a lignocellulosic waste from sugar mills and agricultural processing. The plants grown on sugarcane bagasse yielded a 22% increase in root length, 20% increase in plant height and 63% increase in the number of roots Mohan *et al*., (2004). Bagasse recycled in agriculture as organic fertilizer product. Bagasse also has high nutrient content that is beneficial for plant growth. Bagasse products are biodegradable and compostable.

Onion (*Allium cepa* L.) is a biennial or perennial crop belongs to family Lilliaceae. It is one of most important crop. In India, the major onion cultivating state is Maharastra, Uttar Pradesh, etc.. Onion helps to reduce the risk of obesity, heart disease and cancer. They are rich in vitamins, minerals and antioxidants. Black nightshade (*Solanum nigrum* L.) is perennial crop vegetable belongs to the family Solanaceae. It is one of the most important green leafy vegetable. Solanum nigrum leaves are used in ulcer, asthma, cough and skin diseases.

Solanum lycopersicum L. is an important vegetable crop that belongs to the family Solanaceae. The species originated in western South America. Root decoction is ingested for relief from tooth pain. Tomatoes are rich in lycopene, a substance with beneficial effects to the heart and prostrate. It is also used for rheumatism and headaches. The main objectives of the present investigation was to evaluate the impact of sugarcane trash and bagasse on growth and yield parameters in tomato (*Solanum lycopersicum* L.). Brinjal popularly known as eggplant belongs to family Solanaceae, one of most common vegetable crops grown in India. Brinjal is staple vegetable in almost all tropical countries in the world and utilized by both poor and rich. Its nutritive value varies among varieties. It contains vitamin A and B. The brinjal fruit contains moisture 92.7g, protein 1.4g, phosphorous 47mg, iron 0.9mg, vitamin C 10mg, riboflavin

0.11mg, thiamine 0.04mg, while brinjal may have more medicinal property and is used for Diabetics patients (Palia *et al*., 2021).

OBJECTIVES

- To prepare compost from sugarcane trash and sugarcane bagasse waste using *Pleurotus florida, Trichoderma asperelloides, Eudrilus eugeniae* and Microbial consortium.
- To count and evaluate the microbial population present in compost during 30, 60 and 90 days.
- To analyze physico-chemical parameters of raw and composted sugarcane trash and sugarcane bagasse waste.
- To investigate the functional groups of raw and composted sugarcane trash and sugarcane bagasse waste using Fourier transform infrared spectroscopy (FT-IR).
- To evaluate the role of different compost treatments on the growth and yield of *Allium cepa* L., *Solanum nigrum* L., *Solanum lycopersicum* L. and *Solanum melongena* L.
- To determine chlorophyll 'a', chlorophyll 'b' and total chlorophyll content in leaves of selected plants.
- To study the protein and carbohydrates content in leaves and seeds of selected plants.
- To analyze the pre and post-harvesting soil.
- To analyze the pre and post soil microbial population
- To study the antioxidant and antibacterial activity of the selected plants.

METHODOLOGY

The materials and methods of the study were discussed in the following four phases.

Phase-I

1. Collection of agro-industrial waste
    - Collection of microorganisms
    - Composting procedure
        - ✓ Preparation of sugarcane trash waste compost
        - ✓ Preparation of sugarcane bagasse waste compost
        - ✓ Preparation of vermicomposting trays
2. **Microbial population during 30, 60 and 90 days of composting**
3. **Evaluation of compost maturity**

Lignin - Goering and Van soest, 1975

Cellulose - Updegroff, 1969

pH

Electrical conductivity - ELTOP digital meter

Organic carbon - Wakley and Black, 1934

Nitrogen - Humphries, 1956

Phosphorous - Jackson, 1973

Potassium -Jackson, 1973

Calcium - Jackson, 1973

Magnesium -Jackson, 1973

C:N ratio

4. **Fourier transform infrared spectroscopy (FT-IR).**

Phase-II

The growth and yield of *Allium cepa* L., *Solanum nigrum* L., *Solanum lycopersicum* L. and *Solanum melongena* L.

- Vegetative growth:
  - Shoot length
  - Root length
  - Number of leaves
  - Number of flowers
  - Number of branches
  - Fresh weight
  - Dry weight

- Yield parameters
  - Number of fruits/bulb
  - Diameter of fruit/bulb
  - Single fruit weight/bulb
  - Fruit yield per plant/bulb
  - Fruit yield per plot/bulb

Phase-III

- Biochemical content

No	Biochemical analysis	Reference
1.	Protein	Lowry *et al*., 1951
2.	Carbohydrate	Hedge and Hofreiter, 1962
3.	Chlorophyll	Arnon, 1949

Phase-IV

- Pre and post-harvest soil analysis
- Pre and post soil microbial population
- To study the antioxidant activity
- To study the antibacterial activity.

REULTS

PHASE-I

Collection of agro-industrial waste: The agro-industrial wastes of sugarcane trash and sugarcane bagasse were collected from Thadagam field in Coimbatore.

Collection of microorganisms: The microorganism of *Pleurotus florida* and *Trichoderma asperelloides* were collected from Tamil Nadu Agricultural University (TNAU) Coimbatore and *Eudrilus eugeniae* Kinberg were obtained from Krishi Vigyan Kendra, Coimbatore.

Preparation of composting units

The process of composting consists of six pits (1.5 ft. dimension and 4 sq. ft area). They were named as compost 1 (C_1), compost 2 (C_2), compost 3 (C_3), compost 4 (C_4), compost 5 (C_5) and compost 6 (C_6).

Sugarcane trash compost

Compost 1 (C_1) The sundried 2kg of sugarcane trash agro-waste was transferred to C_1 pit, spread with 20g of *Pleurotus florida* spawn uniformly and sandwiched above with a layer of sugarcane trash waste. This process was repeated till the heap reaches a height of above 1 meter. The moisture content was maintained by sprinkling water at regular interval. Turning the agro-waste was manually done every week during composting process. After 30 days vermicomposting process was adopted.

Compost 2 (C_2) pit was filled with 2 kg of sugarcane trash waste along with 20g of *Trichoderma asperelloides*. This process was repeated till the heap reached a height of above

one meter. To accelerate the decomposition process turning was manually done every week during composting period. After 30 days of composting vermicomposting process was adopted.

Compost 3 (C_3) pit was filled by sundried sugarcane trash waste 2kg. 20g of *Trichoderma asperelloides* and 25 ml of microbial consortium was added. The same process was repeated till it reaches a height of above 1 meter. The moisture content of the pit was maintained for about 60-70% by springling of water in regular interval. To accelerate the composting process, manual turning was carried out every week during composting.

Sugarcane bagasse compost

The same procedure as presented above was repeated. Instead of sugarcane trash (C_1, C_2 and C_3), sugarcane bagasse was used in the following composting pits namely compost 4 (C_4) compost 5 (C_5) and compost 6 (C_6) respectively. The following treatments are used for each pit,

C- Control

C_1- Predecomposted sugarcane trash + *Pleurotus florida* + *Eudrilus eugeniae*

C_2-Predecomposted sugarcane trash + *Trichoderma asperelloides* + *Eudrilus eugeniae*

C_3-Predecomposted sugarcane trash + *Trichoderma asperelloides* + Microbial consortium

C_4- Predecomposted sugarcane bagasse + *Pleurotus florida* + *Eudrilus eugeniae*

C_5-Predecomposted sugarcane bagasse + *Trichoderma asperelloides* + *Eudrilus eugeniae*

C_6-Predecomposted sugarcane bagasse + *Trichoderma asperelloides* + Microbial consortium

Preparation of vermicomposting trays

Plastic trays of 50×35×15cm were bought and holes were made at the bottom to drain the excess water in the experimental trays. Vermibeds were prepared by mixing the pre-decomposed sugarcane trash / sugarcane bagasse along with cow dung in ratio of 1:2 (1 kg of predecompost and 2 kg of cow dung) ratio on dry weight basis in the respected trays (C_1, C_2, C_4 and C_5). The substrates maintained 60- 80% of moisture content and kept for 24 h stabilization. Twenty-five healthy, clitellate individuals of exotic earthworms (*Eudrilus eugeniae* Kinberg) were inoculated into the respective designated experimental trays. The worms entered into the media immediately after the inoculation. Water was sprayed twice a

day to maintain the moisture content. These experimental units were kept undisturbed in a shady place for 40 days. At the end of composting, the compost turned dark in color and the earthworms were separated by sieving.

Physico-chemical composition of the raw and composted sugarcane trash and sugarcane bagasse

The physico-chemical parameters lignin (%), cellulose (%), pH, electrical conductivity (millimhos cm^{-1}), nitrogen (%), phosphorus (%), calcium (%), magnesium (%) and C:N ratio were analyzed in six types of compost and control to assess the compost maturity. Among the six different compost treatments, (C_6) (Predecomposted sugarcane bagasse, *Trichoderma asperelloides* and (*Eudrilus eugeniae*) 5t/h) was found to be an efficient compost, because of the significant reduction in lignin, cellulose, organic carbon and C:N ratio and significant increase in nitrogen, potassium, calcium and magnesium followed by other treatments and control. The C:N ratio is one of the most important parameters that determine the extent of composting and degree of compost maturity. As the decomposition progressed, due to the losses of carbon mainly as carbon dioxide, in the process of respiration, the carbon content of the compostable material decreased with time and production of mucus and nitrogenous excrement enhanced the level of nitrogen, which lowered the C:N ratio.

Microbial population:

During the biocomposting period (30, 60 & 90 days) total microbial population increased up to 30^{th} to 60^{th} day then slightly declined on 90^{th} day. On the 30^{th} day, bacterial, fungal and actinobacteria count was increased in C_5-Predecomposted sugarcane bagasse + *Trichoderma asperelloides* + *Eudrilus eugeniae* followed by C_2-Predecomposted sugarcane trash + *Trichoderma asperelloides* + *Eudrilus eugeniae* compared to control. On the 60^{th} day, remarkable bacterial, fungal and actinobacteria count was obtained in C_5 followed by C_2 compared to the control. During the 90^{th} day of the experiment, bacterial, fungal and actinobacteria population was slightly decreased. Maximum bacterial population was observed in C_5 followed by C_2 over the control. The bacteria, fungi and actinobacteria count was conspicuously increased from 30^{th} - 60^{th} days and from 60^{th} - 90^{th} days it was reduced. The C_5 and C_2 compost increase the micronutrient contents which might have enhanced the total microbial population.

Fourier transform-infrared (FT-IR) spectrum analysis

FT-IR spectra analysis of composted sugarcane trash and sugarcane bagasse waste showed some similar functional groups with different wavelength of peaks. Various organic compounds are present in spectra, significant difference can be observed in C_3 (Predecomposted sugarcane trash, *Trichoderma asperelloides* and microbial consortium) and C_5 (Predecomposted sugarcane bagasse, *Trichoderma asperelloides* and *Eudrilus eugeniae* 5t/h) treatments.

PHASE II

- **Field experiments:** Six compost treatments (T_1-T_6) were applied to the respective beds and control was maintained. A number of biometric observations, biochemical analysis yield parameters content were recorded at different stages during the growth of *Allium cepa* L., *Solanum nigrum* L., *Solanum lycopersicum* L. and *Solanum melongena* L. as influenced by different Days After Sowing (DAS).
- **Collection of seeds:** Seeds of onion (*Allium cepa* L.), black nightshade (S*olanum nigrum* L.), tomato (*Solanum lycopersicum* L.) and brinjal (*Solanum melongena* L.) were obtained from Tamil Nadu Agricultural University.

Biometric characters

Onion (*Allium cepa* L.)

A significant increase in shoot length, root length and number of leaves was recorded in T_3, T_1 and T_2 followed by the other treatments and control on 30, 60 and 90 DAS. Maximum leaf length was recorded in T_3, T_1 and T_2 on 30, 60 and 90 DAS. A remarkable rise in the fresh weight and dry weight were observed in T_3, T_1 and T_2 followed by the other treatments and control on 30, 60 and 90 DAS.

Black nightshade (*Solanum nigrum* L.)

Maximum shoot length, root length and number of leaves were observed in T_4 treatment followed by T_5 treatment when compared to the control on 30, 60 and 90 DAS. Maximum number of flowers and number of branches were noted in T_4, T_5 and T_6 on 30, 60 and 90 DAS. Plant fresh weight was significantly increased in T_4 treatment on 30, 60 and 90 DAS as compared to the control. Maximum dry weight was recorded in T_4 treatment followed by other treatments and control on 30, 60 and 90 DAS.

Tomato (*Solanum lycopersicum* L.)

Shoot length was noticed in T_3 treatment followed by T_1 treatment on 30, 60 and 90 DAS. Minimum shoot length was observed in control when compared to the other treatment. A significant increase in root length was observed in T_3 treatment followed by T_1 treatment when compared to the control on 30, 60 and 90 DAS. Number of leaves were noted in T_3 treatment on 30, 60 and 90 DAS. Maximum number of flowers and number of branches was observed in T_3 treatment followed by T_1 treatment and other treatment when compared to the control on 30, 60 and 90 DAS. Plant fresh weight and dry weight were noted in T_3 treatment followed by T_1 treatment on 30, 60 and 90 DAS.

Brinjal (*Solanum melongena* L.)

A significant increase in shoot length, root length and number of leaves were recorded in T_5 treatment followed by T_3 treatment when compared to the other treatment and control on 30, 60 and 90 DAS. Maximum number of flowers and number of branches was noted in T_5 treatment on 60 and 90 DAS when compared to the control. Maximum fresh weight and dry weight was noticed in T_5 treatment followed by T_3 treatment compared to the other treatment and control on 30, 60 and 90 DAS.

Yield characters

Maximum number of bulbs, diameter of bulb (cm), bulb length (cm), single bulb weight (g) and bulb yield per plot (kg) was more in T_3 treatment followed by T_1 treatment when compared to the control on 90 DAS in onion (*Allium cepa* L.). A significant increase in number of fruits, diameter of fruits (cm), single fruit weight (g), fruit yield per plant (kg) and fruit yield per plot (kg) in T_4 treatment when compared to control on 90 DAS in black nightshade (*Solanum nigrum* L.). Highest number of fruits, diameter of fruits (cm), single fruit weight (g), fruit yield per plant (kg) and fruit yield per plot (kg) in T_3 treatment followed by T_1 treatment when compared to the other treatments and control on 90 DAS in tomato (*Solanum lycopersicum* L.). The number of fruits, fruit length (cm), single fruit weight (g), fruit yield per plant (kg) and fruit yield per plot (kg) was increased in T_5 treatment on 90 DAS in brinjal (*Solanum melongena* L.).

PHASE - III

Biochemical characters

Maximum protein, carbohydrates and chlorophyll a, b and total chlorophyll content in leaves was noted in T_3 treatment followed by T_1 treatment when compared to the control and other treatment on 30, 60 and 90 DAS in onion (*Allium cepa* L.) and tomato (*Solanum lycopersicum* L.). The increase in protein, carbohydrates and chlorophyll a, b and total

chlorophyll content in leaves was observed in T_4 treatment on 30, 60 and 90 DAS in black nightshade (*Solanum nigrum* L.). A significant increase in protein, carbohydrates and chlorophyll a, b and total chlorophyll content in leaves were recorded in T_5 treatment followed by T_2 treatment when compared to the control and other treatment on 30, 60 and 90 DAS in brinjal (*Solanum melongena* L.).

PHASE - IV

Soil status

Initial nutrient status in soil

The results revealed that soil pH, electrical conductivity (millimhos cm-1), available nitrogen (kg/ha), phosphorus (kg/ha) and potassium (kg/ha) were found to be more in T_5 treatment as compared to control.

Post harvest nutrient status in soil

Maximum pH, electrical conductivity (millimhos cm-1), available nitrogen (kg/ha), phosphorus (kg/ha) and potassium (kg/ha) were observed in T_3 treatment followed by other treatment and control in onion (*Allium cepa* L.) and tomato (*Solanum lycopersicum* L.). A significant increase in pH, electrical conductivity (millimhos cm-1), available nitrogen (kg/ha), phosphorus (kg/ha) and potassium (kg/ha) were noted in T_4 treatment in black nightshade (*Solanum nigrum* L.). The maximum pH, electrical conductivity (millimhos cm^{-1}), available nitrogen (kg/ha), phosphorus (kg/ha) and potassium (kg/ha) were recorded in T_5 treatment followed by other treatment and control in brinjal (*Solanum melongena* L.).

Initial Soil microbial population

The soil bacterial, fungal and actinobacteria count increased in all the treatments compared to the control treatment. The maximum increase was noted in C_5 (predecomposted sugarcane bagasse, *Trichoderma asperelloides* and *Eudrilus eugeniae* 5t/h) treatment.

Post harvest soil microbial population

Maximum bacteria, fungi and actinobacteria were observed in T_3 treatment followed by other treatment and control in onion (*Allium cepa* L.) and tomato (*Solanum lycopersicum* L.). A significant increase in bacteria, fungi and actinobacteria were noted in T_4 treatment in *Solanum nigrum* L. and T_5 treatment in *Solanum melongena* L.

Antioxidant and antibacterial activity

All the above analysed data were found to be statistically significant in all the compost as compared to the control treatment. Among the six types of compost, T_3, T_4 and T_5 was found to be an efficient organic manure compared to other treatments. The treatment T_3, T_4 and T_5 significantly enhanced the microbial population, physico-chemical parameters, biometric,

yield and biochemical content, initial and post-harvest soil and soil microbial population of the selected plants namely onion (*Allium cepa* L.), black nightshade (*Solanum nigrum* L.), tomato (*Solanum lycopersicum* L.) and brinjal (*Solanum melongena* L.).

From above the result obtained in the best treatment and control antioxidant and antibacterial activity was conducted with bulb, leaves and fruits extracts of the selected plants.

Antioxidant activity

From the selected plants bulb, leaves and fruit samples were analysed for (DPPH radical scavenging activity, hydrogen peroxide scavenging activity, nitric oxide radical scavenging and reducing power assay). By comparing the four plants it was evident antioxidant activity was shown in fruits extracts of *Solanum melongena* L. followed by *Solanum lycopersicum* L. in the best treatment T_5 – Compost 5 (Predecomposted Sugarcane bagasse, *Trichoderma asperelloides* and *Eudrilus eugeniae* 5t/h) and T_3 – Compost 3 (Predecomposted Sugarcane trash, Trichoderma *asperelloides* and Microbial consortium 5t/h) as compared to control.

Antibacterial activity

Antibacterial activity of *Allium cepa* L., *Solanum nigrum* L., *Solanum lycopersicum* L. and *Solanum melongena* L. bulb, leaves and fruits of best treatment and control were examined against bacterial species. Bulb, leaves and fruits extracts showed better antibacterial activity in all the plants analyzed. Among the extracts of *Solanum nigrum* L. showed highest zone of inhibition against *Staphylococcus aureus* followed by *Solanum lycopersicum* L. The zone of inhibition was moderately differ from each other as compared to the standard antibiotics.

Conclusion

The goal of the current study is to expand the potential applications of agro-industrial wastes like sugarcane trash and sugarcane bagasse wastes for raising crop productivity. Combined application of *Pleurotus florida*, *Trichoderma asperelloides*, *Eudrilus eugeniae* and Microbial consortium were discovered to be the primary decomposers of biocomposted sugarcane trash and sugarcane bagasse waste, making it as a effective organic manure. The present work is not only an alternate solution for the removal of agro-industrial waste of sugarcane trash and sugarcane bagasse waste but minimizes the increased application of chemical fertilizers to crops and encourages organic farming for sustainable crop production. The process is a simple and low-capital investment technology. Composted agro-industrial waste act as a soil conditioner to improve crop quality and increases productivity and reduce the risk of environmental pollution. The present research work confirmed that sugarcane trash and sugarcane bagasse waste compost enhanced the growth, yield and nutrient status in selected

four plants and soil fertility. Hence, it is concluded that sugarcane trash and sugarcane bagasse compost could be effectively used as an organic fertilizer.

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